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HEREDITY OF HAIR FORM AMONG THE FILIPINOS

ROBERT BENNETT BEAN, M.D.
ASSOCIATE PROFESSOR OF ANATOMY,
THE TULANE UNIVERSITY OF LOUISIANA

WHILE connected with the Philippine Medical School in Manila, in the year 1909 two of my pupils, Maria P. Mendoza and Manuel Ramirez, became interested in the heredity of hair form through the work of Gertrude C. Davenport and Charles B. Davenport[1] and they collected the records of 36 families, largely Chinese-Tagalog crosses, although two families were Negritos who had married Filipinos.

They tested the hair form by making sections of hair dipped in thick celloidin hardened in 70 per cent. alcohol and cross-sectioned with a hand microtome, after which the sections were examined under the low power of the microscope, the measurements being made with an ocular micrometer. They divided the forms of hair into—

Straight, with diameters of 100: 90 or over,
Wavy, with diameters of 100: 70–90,
Curly, with diameters of 100: 60–70.

They decided that wherever a union occurred between individuals with straight and wavy hair the straight hair predominated. It seems expedient, however, to consider the hair form in single families as well as *en masse*.

In any discussion of heredity it seems necessary to consider individuals rather than the mass, except in the formulation of laws that take into consideration probable errors in the mass. In Table I, showing the result, in mass, of crossing different hair forms, we should expect, if Mendel's laws prevail, where wavy and straight are crossed or where curly and straight are crossed, to get an equal number of offspring with straight and curved hair

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[1] AMERICAN NATURALIST, Vol. XLII, April, 1908.

TABLE I

Compiled by Mendoza and Ramirez

No.	2d Parental FF FM	2d Parental MF MM	Parent F M	Children C	Children W	Children S	Nature of Mating		Expectation C	Expectation S
1	W S	S S	W S	3	1	1	DR	R	2.5	2.5
2	=	=	W S		3	4	DR	R	3.5	3.5
3	=	=	S S	3		3	R	R		6
4	=	W S	S W	1	5	2	R	DR	4	4
5	=	— W	S W		1	1	R	DR	1	1
6	S S	S S	S S	1		2	R	R		3
7	=	C S	S C	1	0	2	R	DR	1.5	1.5
8	C C	W W	C W	6	1	0	DR	DR	5.3	1.7
9	S —	— S	S W	1		1	R	DR	1	1
10	C S	S S	W S	4	1	2	DR	R	3.5	3.5
11	C S	S S	S S		1	1	R(?)	R		2(?)
12	C —	— C	C W	2		1	DR	DR	2 3	.7
13	—	S W	W S	2	2	1	DR	R	2.5	2.5
14	C W	S S	C S	2	1	1	DR(?)	R	2	2
15	C W	S S	C S	1	1	1	DR	R	1.5	1.5
16	C W	S S	C S	2	1	1	DR	R	2	2
17	= S	K K	S(C) K	4			DR	DR	4	0
18	S(C) S	S S	S C			3	R	DR	1.5	1.5
19	S S	S S	S S			8	R	R		8
20	S S	S S	S S			4	R	R		4
21	S S	S S	S S			6	R	R		6
22	— W	=	W W	2	4	1	DR	DR	5.3	1.7
23	S S	C C	S C	1	1	1	R	DR	1.5	1.5
24	S S	=	S W	1		3	R	DR	2	2
25	S S	=	S W			5	R	DR	2.5	2.5
26	S S	S —	S C	1		5	R	DR	2.5	2 5
27	S S	C S	S C			3	R	DR	1.5	1.5

No.	2d Parental		Parent	Children			Nature of Mating		Expectation	
	FF FM	MF MM	F M	C	W	S			C	S
28	S C	S S	S C	1		2	R	DR	1.5	1.5
29	C C	S S	C S	2		1	DR	R	1.5	1.5
30	S S	=	S C	2		3	R	DR	2.5	2.5
31	S S	S S	S W	1	1	4	R	DR	3	3
32	K K	S S	K S		4		DD	RR	4	
33	=	=	C S	2	1	1	DR	R	2	2
34	=	=	W S	1	1	5	DR	R	3.5	3.5
35	=	=	W S	1	3	2	DR	R	3	3
36	=	S S	S W	1	2	3	R	DR	3	3
37	—y S	— WC	W C	3		2	DR	DR	3	1.25
38	S S	— W	S W		3	7	R	DR	3.5	3.5
39	=	S C	S C	3			R	DR	1.5	1.5
40	=	=	S C	1	1	1	R	DR	1	1
41	— 3	S C	W S	1	5	6	DR	R	6	6
42	=	=	C C	2			DR	DR	1.5	.5
43	— S	C —	W W	1	1	2	DR	DR	3	1
44	W C	S W	W W	2	1	2	DR	DR	3.7	1.25
45	=	C —	S C	2		8	R	DR	5	5
46	=	C S	S W	3		4	R	DR	3.5	3.5

F = father, M = mother, D = dominant, R = recessive, S = straight, W = wavy, C = curly, K = kinky.

where the curved variety is a dominant heterozygote and the straight is a recessive homozygote. Such is the case, for of the 31 families examined in which wavy is crossed with straight or curly with straight, there are 157 children of whom 84 have straight hair and 73 have hair curly or wavy. Where the wavy and the curly are crossed, if each is a heterozygote with the straight recessive, we should expect to find three children with the curved proportion, for of the five families where wavy hair is crossed with curly, there are 33 children with hair of the curved variety and eight with straight hair.

When individual families are considered, however, there seems to be an alteration of the dominance in some cases. Straight hair is dominant in some families, whereas in others the wavy or curly is dominant. In Table I straight hair appears to be dominant in the families numbered 3, 6, 11, 18, 24, 25, 26, 27, 31, 34, 38 and 45. In the first three of these families where both parents have straight hair, and particularly in family 6, curly hair is evidently recessive. If the gametic composition of the two parents in family 3 is Dr×Dr, in which D = straight hair dominant and r = curly hair recessive, then the expected proportion of offspring would be 3 straight to 1 curly haired child. The number of curly-haired children is 3 instead of 1, which is greater than it should be. But if the straight hair be recessive in this family, the gametic composition must be rr×rr where r is straight recessive, and all of the children should have straight hair, which is not true. In any case the number of curly-haired children is in excess of what it should be.

The curved form of hair seems to be dominant in a greater number of families than is the straight, as in families numbered 1, 4, 10, 12 to 16, 22, 28, 29, 33, 35, 36, 39, 41, 43 and 44. In family 1 the proportion of curly-haired children is in excess (excessive dominance) of what it should be even though the curved be dominant. The same is also true for families 4, 10, 13 and 39. There is, on the other hand, imperfect dominance (recessive dominance) of the curved hair in families 14, 15, 16 and 29; or, in other words, there are fewer children with curved hair in these families than would be anticipated if the curved form be dominant.

When kinky hair and straight hair are crossed, as in families 17 and 32, there results an intermediate form—in one family all the children have curly hair, in the other all have wavy hair. The result of crossing two of these intermediate forms is not known unless such a cross is represented by families 8, 12, 22, 37, 42, 43 and 44. There is a tendency toward segregation in these families, but no kinky hair appears.

Judging from this cursory analysis of the families under consideration, the inferences are that in the crossing of different grades of hair-form there is a tendency towards segregation or alternate heredity, a modified Mendelism, for there is not a perfect dominance, nor the opposite, for either of the extreme grades of hair form, kinky (woolly) or straight.

It would be of interest to know what relationship the curly, wavy or kinky hair of the European bears to the same sort of hair of the Negrito. Presumably all of the curly or wavy hair in the families under consideration is of European origin except in families 17 and 32 of Negritos, but in no instance can the previous inclusion of Negrito blood be absolutely excluded. Some of the wavy or curly hair may therefore be due to previous crosses of the Filipino and Negrito. Presumably, also, all of the straight hair is derived from the Filipino, but again the European or Chinese straight hair can not be excluded. It may be that the straight hair of the Chinese and of the European would each have a different reaction in heredity with the curved variety of both the European and the Negrito. Unfortunately, observations to determine this may not be possible owing to the mixed condition of the population at the present time.

It may be well to tabulate the families in which the parents are alike and unlike in hair form and to note the kind of hair of the children, in order to determine somewhat exactly the relative behavior of the different forms of hair in heredity. The following crosses will be considered: Group I, straight × straight; group II, curly × curly; group III, wavy × wavy; group IV, straight × curly; group V, straight × wavy; group VI, curly × wavy.

In this and subsequent tables F. = father, M. = mother. C. = curly. W. = wavy, S. = straight, F.F. =

TABLE II

GROUP I, STRAIGHT × STRAIGHT

No.	F.F.	F.M.	M.F.	M.M.	Children			Parents	
					C.	W.	S.	F.	M.
3	—	—	—	—	3		3	S	S
6	S	S	S	S	1		2	S	S
11	C	S	S	S		1	1	S	S
19	S	S	S	S			8	S	S
20	S	S	S	S			4	S	S
21	S	S	S	S			6	S	S

father's father, F.M. = father's mother, M.F. = mother's father and M.M. = mother's mother.

Here are three families (3, 6, 11) in which the parents appear to be simplex or heterozygotes, and three (19, 20, 21) in which they appear to be duplex or homozygotes, and the straight hair is dominant to the curved variety. The parents in the first three families would have a gametic composition of Dr×Dr in which D represents the dominant character, straight hair, and r represents the recessive, curved hair. In any cross of this nature an equal number of children with straight hair and with the curved variety would be expected and the expectation is realized. The parents in the second three families would have a gametic composition of DD×DD, where D represents the dominant character, straight hair, and only straight-haired children should result from such unions. The gametic composition of the last three families could be rr×rr, where r is recessive straight hair, but if straight hair acts as the dominant character in the first three families there is no reason to suppose that it would be recessive in the last three.

TABLE III

GROUPS II AND III, CURLY × CURLY AND WAVY × WAVY

No.	F.F.	F.M	M.F.	M.M.	Children			Parents	
					C.	W.	S.	F.	M.
42	—	—	—	—	2			C	C
22	—	W	—	—	2	4	1	W	W
43	—	S	C	—	1	1	2	W	W
44	W	C	S	W	2	1	2	W	W
Total					7	6	5		

Family 42 is apparently duplex or homozygote with a gametic composition of cc×cc, but there is nothing to indicate whether the curly hair is dominant or recessive. The wavy haired families behave as if simplex or heterozygote, producing both straight and curly-haired children. If wavy hair is produced by a combination of straight and curly it should behave as it does, representing the heterozygote of the F^1 generation, and in the next generation (F^2) there is a return of the two original forms of hair, curly and straight, and a continuance of the wavy.

TABLE IV

GROUP IV, STRAIGHT × CURLY

No.	F.F.	F.M.	M.F.	M.M.	Children			Parents		Children		
					C.	W.	S.	F.	M.	C.	W.	S.
7	—	—	C	S	1		2	S	C			
14	C	W	S	S				C	S	2	1	1
15	C	W	S	S				C	S	1	1	1
16	C	W	S	S				C	S	2	1	1
18	S (C)	S	S	S			3	S	C			
23	S	S	C	C				S	C	1	1	1
26	S	S	S	—	1		5	S	C			
27	S	S	C	S			3	S	C			
28	S	C	S	S	1		2	S	C			
29	C	C	S	S				C	S	2		1
30	S	S	—	—	2		3	S	C			
33	—	—	—	—				C	S	2	1	1
39	—	—	S	C				S	C	3		
40	—	—	—	—				S	C	1	1	1
45	—	—	C	—	2		8	S	C			
Total					7		26			14	6	7

In some straight×curly families, curly hair seems to be dominant, as in 14, 16, 29, 33 and 39. Whereas in others straight hair seems to be dominant, as in 7, 18, 26, 27, 28, 30 and 45. It will be noted that whatever the character of the father's hair, that character is dominant except in family 39. It is also to be noted that straight hair is dominant when three of the grandparents have straight hair, whereas curly hair is dominant when only two of the grandparents have curved hair. If the hair form of the dominant parent is duplex no recessives are to be expected, but if the dominant parent is simplex half of the children will have little or no dominant hair form. Neither of these expectations is met, except in the families where curly hair appears dominant and there the latter hypothesis fits the facts—14 children have curly hair, 13 have not. We may be dealing with a case of dihybridism in which there is one masked character.[2] The two pairs of characters may be: straight dominant to its absence (curly), and straight dominant to wavy. We should expect on this supposition to get straight, wavy and curly in the proportions: straight 9, wavy 3 and curly 4. The actual number of children with the different kinds of hair is straight 33, wavy 6 and curly 21.

The results of crossing straight and wavy hair may profitably be considered at this point.

TABLE V

GROUP V, STRAIGHT × CURLY

No.	F.F.	F.M.	M.F.	M.M.	Children			Parents		Children		
					C.	W.	S.	F.	M.	C.	W.	S.
1	W	S	S	S				W	S	3	1	1
2	—	—	—	—		3	4	W	S			
4	—	—	W	S				S	W	1	5	2
5	—	—	—	W		1	1	S	W			
9	S	—	—	S	1		1	S	W			
10	C	S	S	S				W	S	4	1	2
13	—	—	S	W				W	S	2	2	1
24	S	S	—	—	1		3	S	W			
25	S	S	—	—			5	S	W			
31	S	S	S	S	1	1	4	S	W			
34	—	—	—	—	1	1	5	W	S			
35	—	—	—	—				W	S	1	3	2
36	—	—	S	S	1	2	3	S	W			
38	S	S	—	W		3	7	S	W			
41	—	S	S	C				W	S	1	5	6
46	—	—	C	S	3		4	S	W			
Total					8	11	37			12	17	14

The father is again prepotent, but there are more exceptions in the straight×wavy cross than in the straight ×curly cross. A great many more curly-haired children (20) appear in the former than wavy-haired children (6) in the latter. The additional factor of dominance associated with the male parent should be noted.

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[2] "Mendelism," by R. C. Punnett, Cambridge, 1907, pp. 44–52.

Davenport and Davenport[3] have apparently overlooked the fact that the mother rather than the father seems to favor dominance in the American families in which the hair form is recorded by them. When the mother has straight hair in a cross of curly and straight, the number of children is 4 curly to 24 straight, but when the mother has curly hair in a similar cross, the number of children is 10 curly to 22 straight. It may be significant that in America, where curly hair is dominant and straight recessive, the female parent is associated with dominance, whereas in the Philippines, where straight hair is dominant and curly recessive, the male parent is associated with the dominant hair form.

It is to be regretted that no observations as to the sex of the children were made by either Davenport and Davenport or Mendoza and Ramirez, because if that had been done the repulsion of maleness or femaleness to one form of hair or another might have been determined, in view of similar conditions that exist in the currant moth and in canaries.[4] It appears, however, that femaleness exerts a repelling influence upon the dominant character among Filipinos but maleness exerts the same influence among Americans.

Returning to the cross of straight and wavy hair, it is to be noted that if straight hair is duplex and wavy hair simplex, then the supposition is that half the offspring shall have straight hair and half wavy hair, and there shall be none with curly hair. But if straight and wavy hair represent two different stages of hair-form either of which may be epistatic to curly, then a certain proportion (usually more than 25 per cent.) of the offspring should have curly hair. Actually there are many children with curly hair (a little over 25 per cent. of all offspring) and consequently the second supposition is favored.[5] We may suppose that the gametic composition of the wavy hair is that of the intermediate form between curly and straight, a heterozygote, cs, and that half of the straight hair is simplex, Sc, and half is duplex, SS. The result of mating curly and straight hair would be offspring in the proportion and with the gametic composition of 2SS-straight hair, 1cc-curly hair, Ics-wavy hair, and this proportion is approximately the truth. There are in Table V 51 children with straight hair, 20 curly-haired, and 28 wavy-haired children.

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[3] *Op. cit.*

[4] "Mendelism and Sex," by C. C. Hurst, pp. 1–34, an address delivered to the Mendel Society, March 29, 1909.

[5] Cf. Davenport and Davenport, "Skin Pigmentation in Man," THE AMERICAN NATURALIST, Vol. XLIV, No. 527, November, 1910.

Only three families occur with a cross of curly and wavy hair. Therefore no conclusions may be safely drawn from them. The curly hair does appear to be dominant in these families, and the straight hair recessive, however, because there are 11 curly-haired children, 3 straight-haired, and 1 child with wavy hair.

The two Negrito families where kinky, or woolly, hair is crossed with straight, have four children with curly hair in the family where one grandmother probably had curly hair, and four children with wavy hair where no such presumption exists. There can be no doubt that in a cross of straight and woolly hair the hair-form blends in the first generation. Curly and wavy hair appears wherever the Negrito and the Malay have been in contact for any length of time in the Philippine Islands, and especially among those who are called Negritos, as the Bataks of Palawan, the Negritos in Mindoro, Panay, Zambales, Cagayan and among the Ilongots. Inferences from the present study are that straight hair predominates in families where the ancestry has a predominance of straight hair. Therefore, the inverse of this should be true, namely, that woolly hair should predominate where the ancestry shows a predominance of woolly hair. This question might be decided by records from Negrito families where both parents have wavy or curly hair. The dominance of straight hair over curly has been indicated in previous studies by the author as in the proportion of

84 straight-haired to 24 curly-haired Filipinos of the Primitive type.[6]

To compare the results obtained from the previous records they may be assembled in one table.

TABLE VI

THE DISTRIBUTION OF THE HAIR AMONG THE CHILDREN OF DIFFERENT MATINGS

Mating	Occurrence				Relative Proportion		
	Total	Curly	Wavy	Straight	Curly	Wavy	Straight
Curly × curly	2	2			100		
Curly × wavy	15	11	1	3	73.3	6.6	26.6
Curly × straight	60	21	6	33	35.0	10.0	55.0
Wavy × wavy	16	5	6	5	31.2	37.6	31.2
Wavy × straight	99	20	28	51	20.2	28.3	51.5
Straight × straight	29	4	1	24	13.8	34.5	82.7
Kinky × straight	8	4	4		50.0	50.0	
Total	229	67	46	116	29.2	20.1	50.7

Three classes may be segregated, taking the relative proportions of curly hair alone. In the first class neither parent shows the dominant character and 100 per cent. of the children have curly hair, which would be anticipated from Mendelian crosses of R × R. In the second class only one parent shows the dominant character and the curly-haired children constitute approximately 50 per cent.—curly×wavy 78 per cent. and curly×straight 34 per cent.—which would be anticipated from Mendelian crosses of R×DR. In the third class both parents show the dominant factor and the curly-haired children constitute approximately 25 per cent.—straight×straight 12 per cent., wavy×straight 20 per cent., wavy×wavy 40 per cent., which is to be expected from DR×DR matings. The proportions are not exactly those to be expected if the straight hair is dominant, due no doubt to the small number of individuals observed, but a tendency towards dominance on the part of straight hair and recessiveness on the part of curly hair is to be noted. Some discordance in the proportions may be due to the fact that when the father has curly hair and the mother straight, the curly hair is dominant, while at other times it acts as a recessive. The fact that 46 families have 47 parents with wavy or curly hair and 45 parents with straight hair, and 113 children with wavy or curly hair and 116 with straight hair indicates that either the curved or the straight may be dominant unless curly and wavy are separable forms, in which case, straight hair should be considered dominant. There are, however, twice as many known straight-haired grandparents as there are curly- and wavy-haired combined. Curly and wavy hair seem to have been latent (recessive) in the grandparents, and predominance of straight hair in the ancestry may make straight hair dominant in heredity.

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[6] Filipino Ears, this journal, Sec. A, Vol. IV. No. 1, January, 1909. pp. 27–53.

SUMMARY

There can be no doubt that hair form blends in heredity when different forms are crossed, and there can also be no doubt that segregation of hair form occurs to some extent in heredity, and one form or another may be dominant under different conditions. There is no exact conformity to Mendel's laws, although there is a tendency in that direction.

There is evident potency in the male when curly and wavy hair are crossed: when the father has curly hair, that form is dominant, and when the father has straight hair, straight is dominant. Wavy hair seems to be a blend of curly and straight in the condition of a heterozygote, each of the two forms, curly and straight, reappearing when the parents are wavy-haired. Wavy hair is epistatic to curly and hypostatic to straight; it may carry hypostatic curly while straight may carry either hypostatic curly or hypostatic wavy. There is evidence of unusual activity of the curly determiner, in spite of the fact that curly hair is usually recessive among the Filipinos.

In conclusion the results observed for Filipinos are not the same as the results recorded by Davenport and Davenport in America but, in general, they are the reverse. When two curly-haired Filipinos are united in marriage the chances are that all their children will have curly hair. Two wavy-haired parents may have straight, wavy or curly-haired offspring. Two straight-haired parents may have children with either straight, wavy or curly hair and the proportion of straight-haired children will probably be large. When one parent has curly hair and the other straight, the greater part of the offspring will have straight hair if the father's hair is straight, but if the father's hair is curly, the proportion of curly-haired children will be larger. But the families of straight- and wavy-haired parents will probably have curly as well as straight and wavy hair, for waviness is usually heterozygous.

Note.—Wherever I may have used the construction and wording previously used by Davenport and Davenport, it was done to emphasize the fact that the results of the observations on the hair-form of the Filipino are different from those found by the two authors in America. I have reversed the terms in applying their language to the facts.

A large number of records would be desirable, both of Filipinos and of Europeans, and records of Negrito and Malay or Negro and European would be especially desirable. The hereditary reactions of different kinds of straight and curly hair may differ, but this could be determined only by more numerous records. Let us hope the records will be forthcoming.